SUMMARY REPORT FOR THE EVALUATION OF THE HAVERFORD-BIONIC INSTRUMENTS OBSTACLE DETECTOR

By
Philip Worchel, Donn Byrne and Robert Young

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SUMMARY REPORT

for

THE EVALUATION OF THE HAVERFORD-BIONIC INSTRUMENTS OBSTACLE DETECTOR

to the

Prosthetic and Sensory Aids Service

of the

Veterans Administration

by

TRACOR, Inc.

Approved by:

Bruce H. Deatherage
Project Director

Prepared by:

Philip Worchel
Donn Byrne
Robert Young

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THE EVALUATION OF THE HAVERFORD-BIONIC INSTRUMENTS OBSTACLE DETECTOR[1]

Philip Worchel, Donn Byrne, and Robert Young
The University of Texas

Bruce H. Deatherage, Project Director, Veterans Administration
Contract V1005P-9639 TRACOR, Inc.,
Austin, Texas

This final report is presented in four sections: (a) the selection of the totally blind subjects, (b) the procedure employed in training the subjects to use the Obstacle Detector (O/D) and in evaluating the effectiveness of the instrument, (c) the analyses of the performance of the subjects with and without the O/D and their subjective reactions to the instrument, and (d) the general conclusions concerning the usefulness of the instrument. For description, development, and instructions in the use of the O/D, see the Summary Report, "Electronic Obstacle and Curb Detectors for the Blind," Biophysical Electronics, Inc. (Veterans Administration Contract No. V1001M-1900, from January 1, 1953 to June 30, 1960), Veterans Administration Obstacle Detector G-5, User's Manual (produced by Bionic Instruments, Inc. Philadelphia, Pa., under Contract No. V1005P-9217), and Bennett, et.al., (1962). The appendices contain copies of the questionnaires, data sheets, and other forms used in the study.

In general, the results of the present evaluation were quite mixed. For the totally blind subjects who normally walk unassisted in familiar territory, the O/D was of considerable aid in reducing the number of collisions and time to walk the experimental course. For the other subjects, who normally use a cane or dog, the O/D was less effective, requiring more time

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[1]The assistance of Mrs. J. F. Smith and Mrs. Gareth McCoy in the selection, training, and evaluation of the subjects is gratefully acknowledged.

and increasing the number of collisions. A number of personality variables were found to be significantly related to subjective evaluation, learning, and performance.

Though no implications can be drawn as to the effectiveness of the O/D with future modifications in instrument design and training procedures, the analyses of the individual results suggest the present areas of possible use, limitations, and direction of future research. Future research is warranted in at least three areas: (1) selection, (2) training and (3) evaluation of any new model, especially one having step-up and step-down detectors.

SELECTION OF THE SUBJECTS

The goal was to obtain a group of adult subjects which would approximate the characteristics of a veteran population as far as age, sex, and education were concerned. Various agencies and institutions in the Austin area were contacted to secure a list of potential subjects. These agencies were: the Texas State Commission for the Blind; Travis Association for the Blind (Lighthouse); Texas State School for the Blind; The University of Texas; the Veterans Administration Regional Office; and the Texas Blind, Deaf, and Orphan School for Negroes. The individuals whose names were supplied from these sources were interviewed, the project described briefly to them, background material obtained, and schedules arranged for participation in the experiment. As an additional source of subjects*, the Texas Lions Camp at Kerrville was quite useful; at this institution, training in the use of the long cane is given over a 12 week period. Each subject's physician was queried in order to obtain information about visual acuity, angle of visual field, cause of blindness, age of blindness, etc. Copies of the letter and the information form which were sent to the physicians are shown in Appendix A.

The subjects and the background information concerning them are shown in Table 1. The mobility figure is based on the Mobility Aids Scale rating (Wright, 1961) which classifies blind persons in terms of how much assistance they require when traveling. This fifteen-point rating system, shown in Appendix B, ranges from 1 (greatest mobility) to 15 (least mobility).

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*Subjects at this camp are dissatisfied with their present mobility aid, or are not using a dog or cane and would like to learn to use a cane. These subjects were added to the study because of the heightened motivation for a mobility aid.

It may be noted that the 26 subjects listed in the table represent a heterogeneous group in terms of each of the descriptive variables. They range in age from 14 to 56 yrs. and in educational level from no schooling to graduate work at the university level. All, however, meet the criterion of total blindness. The age at total blindness ranges from infancy to 43 years, and the causes of blindness include a representative proportion of accidents, diseases, and congenital abnormalities. The least representative variable, perhaps, is that of mobility level in that this group as a whole is a fairly mobile one. In part, this sort of selection is inevitable in that those who refuse to venture into unfamiliar environments would generally not be willing to participate as subjects in research. Of these 26 subjects, it was possible to complete every phase of the evaluation procedure on 14 subjects and a major portion of the evaluation procedure on 19 subjects. Those who withdrew from the project did so for a variety of reasons. For example, several moved away from the city, one suffered a heart attack, and one was stopped by a spouse who objected to his participation. No subject verbalized a dissatisfaction with the O/D as the reason for withdrawal.

ADMINISTRATION OF TESTS

In order to explore the possibility that personality variables are predictors of response to the O/D and also to provide a source for future work with an empirically-derived predictor scale, three psychometric instruments were administered.

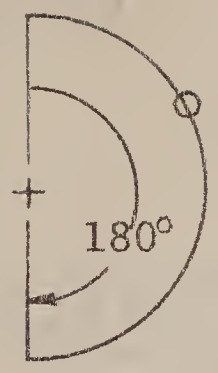
Before any of the training procedures was undertaken, each subject was individually administered the WAIS Vocabulary Test (Wechsler, 1955) and the California Psychological Inventory (Gough, 1957). After completion of the initial training phase, the Emotional Factors Inventory (Bauman, 1958) was administered. In Table 2 are shown the variables measured by each of these three instruments, the scores of the individual subjects, and the means.

PROCEDURE

Training Sessions

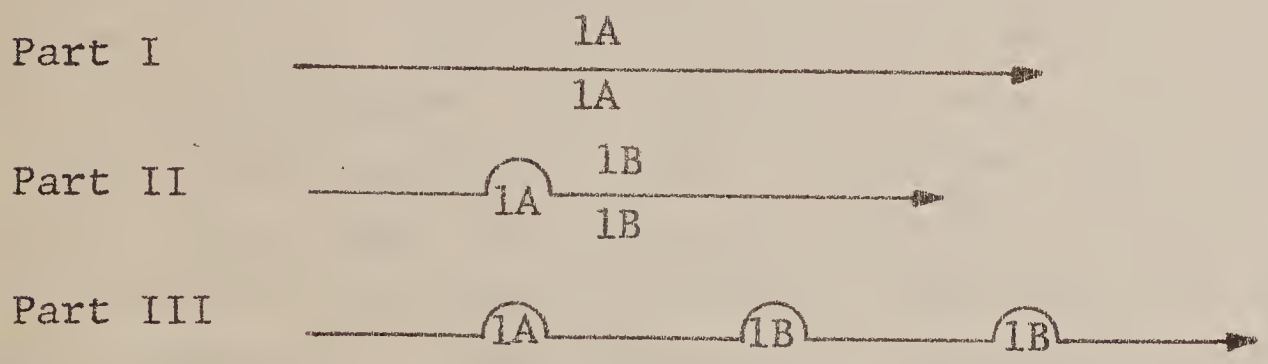
Training subjects in the use of the O/D for the blind followed generally accepted procedures developed by experts in the field of learning over a period of years. The procedure used in the present study may be described as a variation of the "behavior shaping" technique which has been used successfully in such widely divergent areas of training as teaching pigeons to play ping-pong and instructing students of mathematics in set theory. Under such circumstances the subject is first trained to perform successfully relatively simple tasks, then as he becomes more proficient, the tasks become increasingly more difficult. At each stage of difficulty the subject receives training until he can perform the task relatively well, and then he is shifted to a more difficult and complex task. This continues until the subject is able to perform an extremely complex task--such as using the O/D in a crowded store--relatively well. The basic characteristic of this approach is that the subject masters each level of difficulty and then proceeds to a more complex and difficult task until he is performing the desired task at some criterion level.

The training given the subjects may be grouped roughly into three series. The first series has been called Stationary training. In the several parts of this series, subjects would simply stand and attempt to locate the objects with the O/D. The purpose of the series was to familiarize the subject with the O/D so that he would come to know the characteristics of the instrument and what it could do, without any danger. A schematic diagram of the Stationary training is shown on the following page:

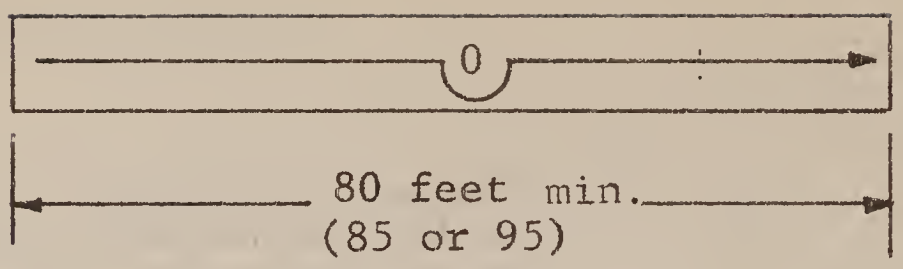


Subject standing at X attempts to locate obstacle at 0, 5 to 10 feet away. (example from Part I)

The second series has been called Traveling training. In the several parts of this series the Subject was first taught to move and to avoid a small number of obstacles. As training progressed, the complexity of the "traveling" and "avoiding" tasks became greater. The purpose of this series was to enable the Subject to learn to avoid obstacles. A schematic diagram of the several parts to the second series is shown below:



Finally an Extended training series was given in which the Subjects traversed an indoor and an outdoor course. Again the complexity of the task increased as training progressed. The purpose was to give the subject training beyond that originally planned. A schematic diagram of the situation for this series is shown on the following page:



(Example from Part I)

A detailed description of the training given in each of these three series is given in the following pages.

Stationary I: Locating single objects. Part I of the stationary series consisted of training the subject to locate by indicating or pointing to the obstacle. For this part of the training, three obstacles, hereafter referred to as A, B, and C, were used. Obstacle A was 5 ft. high, 8 in. wide and was painted mid-gray. Obstacle B was 5 ft. high, 2 in. wide and was painted white. Obstacle C was 2 ft. high, 4 in. wide and painted flat black.

To begin training, following general instructions to the subject about the characteristics of the O/D (See Appendix C), Obstacle A was randomly placed before the subject at a distance between 5 and 10 feet, and somewhere in the 180° arc in front of him. The subject was instructed to stand still and "search" or "scan" with the device until he was able to locate Obstacle A. The subject stood and "scanned" with the O/D until he located the obstacle correctly, located it incorrectly (i.e. indicated that it was somewhere when it was not), or gave up the attempt. If one of the latter two events occurred, the experimenter would aid the subject in locating the obstacle (this was recorded as an incorrect trial). The time it took to locate the obstacle (or make a wrong response) was recorded as well as the correctness of the subject's judgment. The subject was then told to turn around, facing away from the position of the obstacle, and to talk. This procedure was used to provide a masking noise which would permit placement of the obstacle in a new position and yet not provide sound cues to the subject. While this was being done the experimenter would move the obstacle quietly to a new location. Next, the experimenter turned the subject to face in the proper direction, and told the subject to begin a new trial. The subject was required to practice until he could locate Obstacle A correctly on four successive trials. Four successive correct trials constitute the criterion.

It might be well to note here that several criterion measures may be used in a learning experiment. Among these, two

criteria--correct responses or errors and time--have been mentioned. Selection of the proper measure of learning depends upon a number of considerations. In the present experiment, while both time and error measures were taken, correctness was selected as the proper criterion of learning. This was done under the assumption that the consequences of making an incorrect response in a hurry could be more harmful to a blind user of the O/D than would be the consequences of making a slower correct response. Also, if the subject responded rapidly but incorrectly, it would be extremely difficult to conclude that learning was taking place.

After Obstacle A had been located correctly four successive times, the identical procedure was used for Obstacle B. After Obstacle B had been located correctly four successive times, the identical procedure was used for Obstacle C. It should be obvious that the difficulty of locating the obstacle changed as the size and reflectivity of the obstacle changed.

Finally, in the last portion of Part I the obstacles were presented randomly within a series. That is, in the first three series the subject quickly became aware of the characteristics of the obstacle he was searching for. For example, with Obstacle A the subject tended to make a rapid scanning motion with the O/D because Obstacle A was wide enough to return a signal with this procedure. Obstacle C, because it was small and black, was extremely difficult to locate. The subject therefore aimed the O/D toward the floor and slowly scanned back and forth. Thus the strategy the subject used differed with the nature of the obstacle. It was this strategy which training was aimed at modifying in the last portion of Part I.

Obstacles A, B, and C were presented in a random sequence at randomly selected directions from the subject within the 180^{o} arc in front of him. The procedure was identical to that described earlier--the subject turned around and talked between trials he did not move but merely indicated the direction of the obstacle.

Four correct trials in a row was again the learning criterion employed.

Stationary II: Locating objects at various distances.

In this portion, Part II of the stationary training procedure, training in the use of the range switches was given. That is, the subject was not only trained to locate the obstacle but was also trained to estimate the distance of the obstacle by use of the range switches.

In the initial series, Obstacle A was placed on a 180° arc in front of the subject who was asked to locate the obstacle (again by pointing or indicating the direction). In addition, he was also asked to indicate the distance to the obstacle by saying "far"or "near." The mechanics of the range switches were explained and the subject was told that the near range would detect obstacles from 0 to about 5 feet, the mid range up to 10 or 12 feet. The proper procedure then was to locate the obstacle with neither of the range switches actuated and then use the near range switch. If, while the near range switch was actuated, the subject failed to detect the obstacle,it could be deduced that the obstacle was over 5 feet distant. On the other hand, if the O/D picked up the obstacle with the near range switch actuated, then it was under 5 feet. (See Appendix C)

As in the previous series the obstacle to be detected was, from trial to trial, placed in random directions in front of the subject. Between trials the subject turned around and talked to allow the experimenter to place the obstacle in another position without letting the subject know by sound cues where the obstacle was placed. The only difference between the series in Part II and the series in Part I was that the experimenter also randomly varied the distance of the obstacle from the subject from a distance of 1 to 10 feet instead of the previous 5 to 10 feet. Again the learning criterion was four correct successive responses. A correct response here included both locating the direction of

the obstacle correctly and indicating if the obstacle was "far" or "near." It should be noted that some difficulty was experienced in this series because the reflectivity of the obstacle affected the distance of detection. Thus Obstacle C, for example, when 2 feet away from the subject, could be detected only when the O/D was in "middle range." Under such conditions the experimenter might well have scored an error when, within the limits imposed by the O/D, the subject was actually correct. Because of this, the experimenter attempted to adjust for the differences in reflectivity to give the subject both proper training and proper scoring.

Part II consisted of four series. The first three were trials on Obstacle A, B, and C. The fourth series was instituted for reasons previously discussed. The series consisted of random presentations of obstacles at different distances. For example, the initial trials of the fourth series were with Obstacle A at 10 ft. Then random combinations of obstacles and distances were employed. The general procedure was the same as previously described, and four correct successive trials was the learning criterion employed. As in the other series of Part II a correct trial was scored when the subject indicated correctly both the direction of the obstacle and the distance of the obstacle.

Stationary III: Locating several objects. In Part III, two series were employed which differed from previous series only in the number of obstacles used on a specific trial. In the two series of Part III, either zero, 1, 2, or 3 obstacles were used on a single trial. The subject's task was to locate all the obstacles in the 180° arc in front of him. In the first series, the range switches were not used. The subject was simply told to indicate the number of obstacles and direction of each obstacle. Control trials were employed for the first time to reduce guessing on the part of the subject. On these trials, the subject was asked to indicate the direction and location of obstacles when in fact there was none in front of him. It is clear that the nature of

these trials is more nearly like "real-life" situations where there may or may not be obstacles in the subject's path. Again, four correct successive trials were required to reach the criterion of learning, with a correct trial scored when the subject indicated the direction of each obstacle, if there were any. As in previous series, the subject was required to turn around and talk between trials to reduce sound cues as much as possible.

The second series in Part III required the subject to indicate the number of obstacles, and the direction and distance of each. Again Control trials were used to make the situation more like that encountered in real life and to reduce the possibility of guessing on the part of the subject. Four successive correct trials were the required learning criterion.

Traveling I: Learning to Move. In the stationary training subjects had extensive experience with the O/D. This experience, however, concerned learning about the use and characteristics of the instrument itself. As such the subject became proficient in the location of objects in front of him but at this point the instrument had not been used for the purpose for which it was designed--traveling. The several Traveling series were designed to train the subject in the rudiments of traveling or moving while using the O/D as an aid.

In Part I of the Traveling series subjects were trained to move toward and then between two obstacles. As in the Stationary series the experimenter placed the obstacles somewhere on the 180° arc. When two were placed, they were at the ends of a chord. The subject's initial line of travel, whichever direction it might be, was in the first series of Part I, two obstacles of type A were used. The obstacles were placed at random distances in front of a subject and changed after every trial. As in the case of the stationary series the subject was required to turn around after returning to the starting point and talk. Four correct responses on successive trials constituted the criterion of learning. In each of the series of Part I a correct response

was scored when the subject went between and avoided the two obstacles.

There were three series in Part I using successive parts of obstacles of types A, B, and C.

Traveling II: Moving and avoiding obstacles. The second portion of the Traveling series, Part II, was much the same as Part I with the exception that subjects were required to avoid obstacles while attempting to move between pairs of obstacles. For example, in the first series of Part II, the subject was again required to move between two A obstacles, positioned so as to form a chord on the 180° arc in front of the subject. However, in addition to this, Obstacle B was placed somewhere in front of or behind the two A obstacles. The subject's task in this Part then was to move between obstacles and avoid colliding with the one in the path. In each series a correct response was scored when the subject went between the two obstacles and avoiding them and in addition avoiding the extra obstacle. If the subject failed to go between the appropriate obstacles or made contact with any of the obstacles an incorrect response was scored. Again four correct responses on successive trials was the learning criterion used.

Three series were used in Part II. The first, mentioned above, required the subject to go between Obstacles A-A and, in addition, to avoid Obstacle B. The second series required the subject to go between Obstacles B-B and to avoid Obstacle A. The third series employed Obstacles B-B and required the subject to avoid Obstacle C.

Traveling III: Avoiding Obstacles. In the final portion, Part III, of the Traveling series, the subject was required to traverse a path upon which obstacles were placed. The subject's task was to avoid those obstacles while still staying on the path. The path varied according to local conditions. Sometimes the subjects were to approach directly toward the experimenter as he talke

sometimes they were to travel as close as possible to a wall in a very large room. In any event the subjects were cautioned against avoiding the obstacles by taking an extremely circuitous route. They were instructed to stay on the path, instead.

In the first series of Part III, subjects traversed the path upon which were placed Obstacles AAB in random order. The subject was required to avoid each of the three obstacles for the trial to be scored as a correct response. Again, four successive correct trials were used as the criterion of learning.

In the second series of Part III four obstacles were used. These were AABB. Again these were placed on the path in random orders with random distances between them. As in previous series, four successive correct trials were required. The third series used Obstacles AABC. The fourth series used Obstacles BBCC. Task difficulty increased progressively from series to series.

Extended Training.

After training on Parts I-III, the subjects were considered ready for testing on the Standard Obstacle Course which had been set up to compare performance with the O/D and performance using the preferred mode of travel. Such testing was undertaken on an indoor and on an outdoor course. It became obvious that the subjects did not have sufficient training, particularly on the indoor course. While the subjects were proficient at traveling in an open space and performing such tasks as going between obstacles or through door ways, they had not received enough training to enable them to perform under conditions such as those which would be encountered when the subject was attempting to travel along a crowded corridor. For this reason an extended period of further training was given. Two additional sections were added to the training schedule which were identical except that one section was given out of doors while the second section was administered indoors in a relatively narrow corridor. The narrow corridor was selected because the subject needed training under conditions in which the

O/D indicated a barrier or obstacle in almost any direction. Previous training did not have this characteristic because it had taken place in a large empty room. Outdoor training was given first, followed by indoor training. The outdoor course consisted of an 85 ft. sidewalk while the indoor path was a 95 ft. corridor. Because of the similarity between the indoor and outdoor procedures only one will be described.

Part I: Avoiding Single Obstacles. Eight obstacles were used in the Extended Training sessions. (See Appendix D.) In each of the eight series of Part I the subject was asked to traverse the path and avoid the single obstacle placed somewhere along it. The position of the obstacle would differ from trial to trial as well as from series to series. The subject was required to avoid the obstacle successfully on two successive trials.

Part II: Avoiding Two Obstacles. Combinations of two of the eight obstacles listed in Appendix D were used in the series of the second part. The first series consisted of the White Wall and the Wire Basket set 15 ft. apart and placed somewhere along the path. The White Wall and Wire Basket were moved after every trial. Learning criterion for each series in Part II was two successive successful traversals. The other series of Part II consisted of the Garbage Can and the Wood Box set 15 ft. apart, the Person and the Chair set 10 ft. apart, and the Black Wall and the Wire Basket set 5 ft. apart. Following every trial in each series the location of the obstacles was changed to avoid the possibility that the subject might memorize their locations.

Part III: Avoiding Three Obstacles. In each of the three series of Part III the subject was required to attempt to avoid three of the obstacles on every trial. In the first series the White Wall, the Wire Basket and the Silver Poles were used. These obstacles were set 10 ft. apart. In the second series the Garbage Can and the Wood Box were 10 ft. apart while the Black Wall was set 5 ft. from the Wood Box. In the third

series the Person, Chair, and the Wire Basket were used at intervals of 15 and 5 ft., respectively. The positions of the obstacles were changed after every trial and the learning criterion on each series was two successive correct trials. In this part a correct trial was defined as the avoidance of all three obstacles.

Part IV: Avoiding Four Obstacles. In this part of the training two series of four obstacles were used. In the first series the White Wall, the Chair, the Garbage Can, and the Wire Basket were used. The intervals were 15 ft., 5 ft., and 10 ft., respectively. In the second series the Person, the Wood Box, the Black Wall, and the Silver poles were employed. The distances between the obstacles were 5 ft., 10 ft., and 5 ft., respectively. As in the other parts, a learning criterion of two successive correct trials was used. In this section a correct trial was defined as the avoidance of all four obstacles successfully.

TEST TRIALS

The procedure consisted essentially of three main parts: Pre-training performance with the customary mode of travel (without O/D), a training series to acquaint the subjects with the instrument and to provide practice in the use of the O/D under various conditions and with various obstacles, and a post-training test series to determine the effectiveness of performance. The pre- and post-training series used two test situations: a standardized indoor and outdoor obstacle course, and a relatively unfamiliar city block. Three training sessions were conducted: a laboratory series with a definite schedule and a standard set of obstacles, a free and unsupervised period with the O/D for two weeks, and ten one-hour supervised sessions in the use of the O/D under field conditions. Probably it would have been better to give the ten hours of supervised field training immediately after the laboratory and before the unsupervised period to prevent errors in the use of the O/D and unnecessary collisions which might give rise to negative attitudes towards the O/D. Only after the unsupervised session, however, did we think it necessary to provide further training in order to emphasize speed.

Pre-learning series. To obtain a base line performance for evaluating the O/D, a pre-training series of trials, where each subject used his customary travel aid while blindfolded, was conducted on two standard obstacle courses: (a) a concrete outdoor sidewalk, 85 x 4 ft. bordered on both sides by grass, and (b) an indoor corridor, 95 x 5 ft. Eight obstacles, varying in width, height, and material were used (See Appendix D). Five trials were given to every subject on each obstacle course. Appendix E shows the order of the trials and the placement of the obstacles on each trial. Both errors (collisions) and time were scored. An error was counted when any part of the body touched an obstacle. Time was measured from the moment when the subject was placed on the starting position and given the signal to begin walking until

he had walked to the end of the obstacle course (85 and 95 ft. respectively). The following instructions were read to each subject at the beginning of the first trial:

"Walk down (up) the hall (sidewalk, making sure you don't step off the walk) at your usual pace trying not to touch any of the obstacles with any part of your body. I will let you know when to stop."

At the end of each trial the subject was disoriented by the experimenter walking him around randomly for several turns. During this time, an assistant would move the obstacles noiselessly for the next trial. Twenty-five subjects took the pre-learning series. One subject (M) did not take this series as he had suffered a slight heart attack.

First post-learning evaluation. Soon after the blindfolded subject had completed the first series of training sessions, he was brought out to the standard obstacle course. The procedure here duplicated that in the pre-training series with the exception that the subject now used the O/D. Five trials were given on the indoor and outdoor course in the same order and with the same placement of the obstacles as in the previous series. A second post-learning series was given after a practice period which included the free use of the O/D for a period of two weeks (the subject was instructed to use the O/D for at least one hour per day). Nineteen subjects were available for this series of tests. Six subjects of the original 25 left town before the first post-learning tests (mainly because the school year ended) and only 14 were available for the second evaluation series (4 had left the Kerrville L. C. and 1 left the School for the Blind).

Field training under supervision. In this session, each subject spent about one hour per day for ten days walking with the O/D in six semi-familiar and unfamiliar areas accompanied by a trainer. The role of the trainer was to coach the subject in the

proper use of the O/D, to emphasize the avoidance of obstacles, and for the first time in a training session, the subject was instructed to walk as rapidly as possible. Whenever the subject held the instrument or scanned improperly, the trainer pointed out the proper procedure. The trainer assisted the subject to use range switches properly, helped him to maintain motivation by the use of praise and encouragement, and reassured him in the avoidance of any danger. The trainer noted collisions (number and kind) and reported comments made by the subject. In view of the differences in operation from instrument to instrument, the same O/D was ordinarily used by any one subject (unless failures in operation occurred).

Unfamiliar Obstacle Course

Following the supervised training session, each subject was then evaluated on his use of the O/D in an initially unfamiliar city block (except for one subject, R, who was quite familiar with this area). Four trials were given to each subject on this same block, i.e. walking up and back twice, in a counterbalanced order with the O/D and with customary mode of travel. The subject walked the entire length of the block as quickly as possible, entering and leaving a store in the middle of the course. The experimenter walked to one side a step or two behind the subject without comment (except to avoid danger), noting time and collisions. For one subject, the first trial was with the O/D, the return trial was with the customary mode of travel, and the final return trial was with the O/D. For the next subject, the order of trials was reversed: customary mode, O/D, O/D, and customary mode. Fourteen subjects traversed the course.

Speed Session

The final evaluation session of the O/D was on the standard obstacle course used in the first two evaluation sessions. The subjects were instructed on each of the 10 trials (outdoors and indoors) to walk as rapidly as possible, to locate a "hole" and

not be concerned about the size or kind of obstacle. After all trials were completed, the subject was again interviewed concerning his reactions to the O/D and his suggested changes, if any. Eleven subjects were available for this part of the study. Three subjects (S,V,X) had left the Blind School at the end of the school year prior to this test.

Summary of sessions. The following sequence of training and evaluation summarizes the procedure used for each subject:

1. Pre-Learning (base performance on obstacle course)
2. Training A (laboratory)
3. First Post-Learning Evaluation (obstacle course)
4. Unsupervised Use of O/D (two weeks--at least one hour daily)
5. Second Post-Learning Evaluation (obstacle course)
6. Field Training Under Supervision (ten hours)
7. Field Evaluation (unfamiliar course)
8. "Speed" Evaluation (obstacle course)

The subjects who completed the entire series took a total of about 30 hours of supervised training and at least 10 hours of unsupervised practice.

RESULTS

Table 3 summarizes the data on the obstacle course for all blind subjects before training (with customary mode of travel) and after training (with O/D). Nineteen subjects completed the first post-learning evaluation and fourteen of these subjects were available for the second post-learning tests following two weeks of unsupervised use of the O/D.

There were wide individual differences in pre-learning performance. Errors ranged from a mean of 0.2 to 5.4 on the outdoor course and from 0.4 to 5.6 on the indoor course. The highest number of errors occurred in the subjects who used neither cane nor dog as a travel aid. As a matter of fact all these nine subjects except one exceeded all the others in errors. They also took the longest to walk the obstacle course. As would be expected, the subjects with the dog aid were consistently the fastest on the course. It is interesting to note that it made no difference whether the subject walked indoors or outdoors. The means for time and errors were practically identical. The rank order correlation for errors between the two courses was .90.

Over-all Evaluation

The most direct test of the efficiency of the O/D is to compare the performance of the subjects traversing the course without and with the O/D. Table 4 shows the results according to the mode of travel. Only the errors and time for the first post-learning tests were used for this analysis since more subjects were available for this series. Besides, the means for the two post-learning series were 1.8 and 143 seconds outdoors, and 1.8 and 141 indoors. For the second post-learning tests, the means were 1.9 and 140 seconds outdoors, and 1.7 and 132 seconds indoors.

From Table 4, it is seen that the mean scores for all nineteen subjects before and after training show little change in the number of errors but almost a threefold increase in the time to

traverse the obstacle courses*. It took on the average 2.01 and 1.97 errors on the two courses before training and 1.89 and 1.82 errors with the O/D. The time to walk the course with the usual mode of travel was 50.8 and 59.8 seconds. With the O/D, it took on the average 142.4 and 147.2 seconds to walk the same course. Over-all then, it seems that the O/D resulted in a decrease in efficiency as far as time is concerned and practically no gain at all in avoiding obstacles. These results, however, are misleading. Inspection of Table 4 shows clearly that the five subjects who customarily use no aid did much better with the O/D with respect to errors. On the average, they cut their errors almost in half when using the O/D: from 4.36 to 2.20 outdoors, and from 3.88 to 2.16 indoors. Significantly, all the five subjects did better with the O/D. Time, however, was much poorer. For those subjects using a cane or a dog, the O/D was of little help. As a matter of fact, they did somewhat poorer with O/D. The increase in errors for these subjects and the over-all increase in time may be due to (a) insufficient training on the O/D, (b) the difficult and somewhat unrealistic obstacle course, (c) low motivation for those subjects already using a travel aid, (d) too little emphasis on speed, and (e) the subject's interest in exploring the environment rather than avoiding obstacles. Further training was therefore provided as described in the procedure with emphasis on avoidance of obstacles and speed in walking with the O/D.

Speed trials. Eleven subjects were retested on the same obstacle course under instructions to walk as rapidly as possible. Table 5 shows the errors and time for these subjects. A comparison of the results under these conditions with those on the first post-learning series (Table 6) shows clearly the significant decrease

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*Despite the experimenter's encouragement to move along at their usual rate, the subjects tended to pause and "examine" detected obstacles with the O/D. The new experience evidently aroused their curiosity and led them to explore rather than traverse the course without regard for the objects encountered.

in time with little increase in errors. The time was cut almost in half. Compared to the pre-learning series, the subjects took about fourteen seconds longer on the average during the speed trials. Thus there is no doubt that the instrument can be as effective as the cane as far as speed is concerned. The two subjects in the speed trials who customarily use a dog (AC and TT), however, still do much better with the dog than with the O/D.

Field tests. The final over-all evaluation consisted of the comparison of the performance of the subjects on a relatively unfamiliar city block without (using customary mode of travel) and with the O/D. Table 7 shows the results for the fourteen subjects who were available for this part of the study. On the average, the subjects made fewer errors in their customary mode of travel, and took longer than they did with the O/D. The over-all picture is again somewhat misleading. Except for one subject (R) who was familiar with this city block, the subjects who customarily use no travel aid did far better with the O/D on both errors and time. All the other subjects walked faster with their customary aid. Here again, it is possible that with more training in semi-familiar and unfamiliar situations and greater emphasis on speed and avoidance of obstacles, these subjects might improve their performance considerably with the O/D.

Obstacle collisions. In the standard obstacle course, a contact of any part of the body with an obstacle was scored as an error. Eight obstacles varying in size, color, and surface were used. Analysis of the errors on each obstacle may indicate the difficulties of the "instrument-man" system in detecting and avoiding certain kinds of obstacles. Table 8 shows the total errors occurring on each obstacle in the pre-learning, and speed trials. Since there are a different number of subjects from series to series and a different number of trials on the obstacles (six trials on the white and black walls, four trials on the doorway, and ten trials on all the others for both indoor and outdoor series

combined), the per cent errors were calculated on the basis of the total trials for that particular obstacle. This adjustment allows direct comparison within any one series and between the different series.

The pre-learning data show that the most difficult obstacles to avoid (above 40 per cent errors) were the doorway, poles, and "person" for the subjects with a cane; the "person" for those with a dog; and the garbage can, doorway, poles, and wood box for those who walked unassisted. In general, narrow openings (doorway), for those with a dog and cane, and both low obstacles and narrow openings, for the unassisted, are most difficult to avoid. On the other hand, the white and black walls offered little problem.

With the O/D, the narrow opening and low obstacles still presented quite some difficulty in avoidance on the post-learning trials. On the speed trials, the garbage can and the doorway were hit in almost half the trials.

Training

The results of the training sessions with the O/D are presented in Figures 1 and 2. In Figure 1 are presented the data from the three parts of the Standing and the three parts from the Traveling sessions. It can be seen from Figure 1 that two groups are represented--the subjects who normally used canes and the subjects who did not use any device to move around. Two other subjects normally used guide dogs. The data from these subjects are not presented because the number of subjects in this category was felt to be too small to be representative and hence the data are probably unreliable. At the beginning of training, there was a slight difference between the cane users and the unaided. It took the cane users fewer trials to learn the initial series in Part I; it took fewer seconds per trial to learn and in so doing the cane users made fewer errors than did the non-cane users. By the end

of the training in the moving sessions the initial advantage shown by those who normally use canes had largely disappeared. That is, on Part III of the moving sessions we see that there is almost no difference between the cane subjects and the unaided subjects.

Quite remarkable differences begin to show themselves in the data presented in Figure 2. The differences between the cane subjects and the unaided subjects become relatively large. The cane users are learning in fewer trials, making fewer errors per trial and traversing the course faster than are the unaided subjects. This is especially noticeable in Part IV of both the indoor and outdoor sessions.

Subject's Evaluation

At two points during the experimental procedure, each subject was given a structured interview in order to obtain his reaction to the O/D as a travel aid and to elicit suggestions about it. The first interview was administered after the initial training phase and the post-learning trials and the second after the two weeks of free use. The interview blanks are shown in Appendix F.

We will examine both the formal evaluation of the O/D which the subjects were requested to offer and also the various comments and suggestions which they made about it. In Table 9 are shown the subjects and their responses to the three evaluation questions in the first and in the second interview. It is clear that there are marked differences among subjects in their reactions to the instrument. For example, at the time of the first interview, 23% of the subjects had no desire to own an O/D, 9% did not care, and 68% did express a desire for ownership. At the time of the second interview, the comparable figures are 33%, 27%, and 40%. For those who took part in both interviews, 10 did not change their opinion about owning one, 2 changed from yes to no, 2 changed from yes to don't care, and 1 changed from no to yes. These

differences in reaction to the O/D suggest that it would be extremely useful to be able to predict those who would and those who would respond positively to such an instrument. In a later section, one step in the attainment of such individual prediction will be presented.

Though the samples are too small for much confidence in the findings, it should be noted that those subjects who presently use guide dogs were the most positive toward the O/D, those who use no travel aids were the most negative, and the cane users fell in between the other two groups.

Subject's Comments and Suggestions

One portion of the interviews requested the subjects to respond to open-ended questions concerning the O/D, their reaction to it, and their suggestions about its strong and weak points. The questionnaire items are presented below with a summary of the comments given in reply. The number of subjects out of the 22 queried who gave each response is indicated in parentheses.

#3a. Where do you think you would be most likely to use it? In what sort of situations would it be of help to you?

Familiar situations	(6)
Street and other crowded places	(6)
Places without steps	(2)
Indoors	(2)
General travel	(1)
Where there are parked cars	(1)
Where there are no moving objects	(1)
Where there are no crowds	(1)

#3b. Where do you think you would be least likely to use it? In what sort of situations would it be of no help to you?

Crowded places	(6)
Familiar territory	(7)

Crossing a street	(5)
Where there are stairs	(4)
Unfamiliar places	(3)
Indoors	(3)
Places with low hanging limbs or signs	(1)
Where there are moving objects	(1)
Outdoors	(1)

#5. What, in your opinion, are the best features of the Obstacle Detector?

Extended range so you can pick up distant objects	(16)
Can take it anywhere (unlike a dog)	(2)
Small enough not to be noticeable	(2)
Less clumsy than a cane	(2)
Would detect an unfamiliar object in a familiar place	(2)
The radio attachment	(1)
Easy to charge and maintain	(1)
Economical to operate	(1)
Easy to travel with	(1)

#6. What, in your opinion, are the worst features of the Obstacle Detector?

Inability to determine step-downs and low obstacles	(10)
Too heavy and tiring	(9)
Arrangement of range settings	(6)
Won't pick up some objects (black, dark, glass)	(5)
Unreliability; range varies with strength of batteries	(5)
Charging takes too long	(3)
Won't pick up high obstacles, overhangs	(3)
Must walk slowly to use it effectively	(2)

Don't like the noise it makes	(1)
Hard to tell the width of objects	(1)
Can't identify the material objects made of (unlike cane)	(1)
Conspicuous	(1)
Doesn't help you go in a straight line	(1)
Feel insecure because it is intangible	(1)

#7. Could you think of any changes that might be made in the instrument which would improve it?

Make it less bulky	(10)
Incorporate with a cane	(8)
Switches should be easier to use	(7)
Make beam or something to detect curbs, steps, small objects	(3)
Smaller transmitter	(1)
Should be a way to turn it off while still holding it	(1)
Add a reflector to give a four-foot wide patch	(1)
An automatic scanner	(1)
Make it more attractive so it wouldn't be conspicuous	(1)

#8. Do you have any other general comments about the Obstacle Detector?

It's of some help, but it needs to be worked on	(7)
It's a good idea	(1)
Would be useful before other travel aids are learned	(1)
Not useful until after experience with other travel aids	(1)
I found it a very interesting and unforgettable experience	(1)
Hope it will be perfected and made available to blind people	(1)
It would be very good for deaf-blind people	(1)

The consistent reactions which stand out most clearly may be summarized as follows. On the positive side, the O/D is seen as useful in familiar situations and in flat places without step-ups or step-downs, the extended range provides information about distance not available with other travel aids, it is easy to carry around, and with a few changes it would be in much demand. On the negative side, some are afraid to trust it in crowded places or in crossing streets, the problem of stairs and curbs and step-downs is not solved by the O/D alone, the switch arrangement is seen as unreliable both in terms of objects it will detect and in terms of variations in the strength of the beam as the battery loses strength, and it is felt to be too heavy to use comfortably for more than a short period of time.

Individual Differences

The primary reason for obtaining much of the background data and scores on the psychometric instruments was to explore the possibility of isolating those variables responsible for differential reactions to the O/D as a travel aid and differential aptitude in learning its use.

In the analysis of results which follows, three points should be noted. First, the total sample is a relatively small one and thus generalization to the total blind population is somewhat hazardous. Second, a related point is that a cross-validational study is badly needed in order to eliminate chance findings and hence verify those relationships which are valid. Third, because of the variations within the group in terms of the number of steps in the total procedure which were completed, the number of subjects on which the various Pearson product-moment correlations is based varies between 11 and 19. In each instance, however, the reported significance levels are computed on the basis of the actual number of subjects involved. The first analysis, presented in Table 10, concerns the interview scales on which the subjects

indicated their general evaluation of the O/D, their notions about its usefulness, and their desire to own one if it were made available. Each of these ratings was quantified as a simple ordinal scale and correlations computed between the ratings and each other variable.

An examination of Table 10 reveals a few interesting relations which are suggestive for future research. In the first place, a subject's response to the O/D on the first interview (following training) was not a particularly good predictor of his response to it at the time of the second interview (following an opportunity to try it out on his own for two weeks). General evaluation on the two interviews correlated .07, usefulness on the two interviews correlated .63, and desire to own one correlated .49 on the two interviews. With those relations, it is not surprising to find somewhat different patterns of correlations for the two interviews as shown in the table.

One consistency was the relationship between mobility scores and evaluation; the less mobile the subject, the more positive their evaluation of the O/D. It is also interesting to note the rather substantial negative relations between number of errors in the post-learning trials and both general evaluation and ratings of usefulness. The more errors the subjects made, the less positive they were toward the instrument. One possibility which might be suggested is that learning procedures which progressed carefully enough to avoid failure experiences for the subjects would result in the avoidance of the development of negative affect toward the O/D. With respect to their desire to own on O/D after experience with it in the training period, those subjects who wanted one tended to be less well educated, less self-accepting, more masculine and outgoing, and less intelligent.

At the time of the second interview, after free use, very few of the predictor variables are related to their evaluation

of the O/D. The few relations that are found are primarily with respect to their ratings of its usefulness. Those subjects who found the O/D most useful tend to be deliberate, patient, literal-minded individuals. They tend to take a short amount of time in the pre-learning indoor trials, a relatively long amount of time in the first stage of learning, and tend to make more errors on the post-learning outdoor trials. The latter findings do not make much conceptual sense and tend to suggest chance relations which may possibly stem from insufficient training.

The second major problem of individual differences is that of efficiency in learning the use of the O/D. Correlations with learning and performance variables are shown in Tables 11, 12, and 13.

With the learning variables in the three stages, shown in Table 11, relatively few relations were found with the predictor variables. Briefly, those who were most efficient in learning tended to be more retiring and inhibited, more peaceable and serious, more deliberate and cautious, and to have fewer somatic symptoms than those subjects who were least efficient in learning the use of the O/D.

Table 12 presents data relevant to the obstacle course performance. First, it should be noted that there is no relation between the number of errors made in the obstacle course and length of time required to traverse it. For the four pairs of errors and times shown in Table 12, the correlations are .18, .20, -.10, and -.28. Therefore, the findings will be discussed separately for errors and time. Those subjects who made the fewest errors in the obstacle course trials tended to be older, less mobile, more planful and responsible, more serious and industrious, more cooperative and enterprising, more capable and efficient, more deliberate and cautious, more patient and persevering, and to have more somatic symptoms than those who made the most errors. With

respect to time, however, those who went through the most quickly tended to be less well educated, more mobile, more immature and lazy, more literal-minded and simple, more conservative and conventional, more impatient and changeable, more confused and defensive, to have fewer somatic symptoms, to have more problems in adjusting to their blindness, and to be less intelligent than those who required the greatest amount of time to get through the obstacle course. It would seem that the best adjusted individuals use the O/D very effectively with respect to avoiding obstacles but that they also require a somewhat greater amount of time to move down the pathway.

Finally, in Table 13 are presented the correlates of performance on the street-travel trials with and without the O/D. The correlation between errors with and without the O/D was -.20. Interestingly enough, two distinctly different patterns emerge with respect to those subjects who are most effective in using the O/D vs. those who are most effective without the O/D. Those individuals who made the fewest errors in traversing the course using the O/D tended to be more ambitious and active, more outgoing and enterprising, more outspoken and sharp-witted, more planful and responsible, more capable and cooperative, less neurotic and emotionally unstable, to have fewer somatic symptoms, to feel more socially competent, and to have fewer feelings of inadequacy and inferiority than those individuals who made the most errors in using the O/D. Those who did well with their traditional mode of travel aid tended to be more retiring and inhibited, more awkward and conventional, more deliberate and moderate, more immature and lazy, more defensive and demanding, more suspicious and aloof, more anxious and cautious, more easygoing and unambitious, more distrustful of others, and to have greater feelings of inadequacy and inferiority than those subjects who made relatively more errors with their traditional mode of travel. These findings suggest that those blind individuals who have mastered the use of the O/D sufficiently well to utilize it most efficiently in a real-life

situation are more effective psychologically and better adjusted than are those individuals who are unable to do so. The possibility of predicting effective O/D users on the basis of scores on these personality tests seems very promising.

CONCLUSIONS AND RECOMMENDATIONS

On the basis of the present series of studies on the effectiveness of the Obstacle Detector with a select group of totally blind subjects following a particular training schedule, the following conclusions and recommendations are offered:

1. There were wide individual differences in pre-training performance on a standard obstacle course. The highest number of errors and the longest times occurred with those subjects who normally walk unassisted. The most effective were those blind subjects who used a dog. In between the two groups were the cane-users.

2. Using the Obstacle Detector on the standard obstacle course, all subjects, on the average, took about three times longer to walk than with customary aid. Errors with and without the O/D were about the same. Analysis of errors and time according to mobility aid, showed that subjects who walk unassisted made much fewer errors with the O/D than without it. For those subjects using a cane or a dog, the O/D was of little help and probably was even a hindrance. It is possible, however, that the opportunity to "explore" slowed these subjects.

3. After considerably more training on the use of the O/D, the subjects reduced the time to walk the obstacle course significantly, when instructed to proceed as rapidly as possible, while errors remained about the same.

4. On the field tests, this group, on the average, made fewer errors but took somewhat longer with the customary mode of travel than with the O/D. Again, however, the subjects who normally walk unassisted did far better with the O/D in the field trials.

5. An analysis of the collisions on the standard obstacle course showed that the subjects, in general, had most difficulty in avoiding narrow openings and low obstacles.

6. During the training sessions, the subjects had great difficulty in detecting Obstacle C, the flat black wall, 24" high. Often it could only be detected when the subject was within a few inches of it.

7. The effectiveness of the O/D varies with the degree to which it is charged. A recently charged O/D, for example, would pick up a signal at 10 ft. and the same instrument, when considerably discharged, would pick up the same object at a maximum of 5 ft. on the same range setting.

8. Cane users and "unassisted" blind subjects were about equally effective in the first part of the training sessions, but toward the end of the sessions, the cane users made fewer errors and took less time. This difference might have been due to better motivation, previous use of a travel aid (cane), or better acceptance of "blindness" and need for aid.

9. Most of the subjects complained about the location of the far-range button. It was inconvenient to use.

10. About one half of the subjects indicated a desire to own the O/D. Those who presently use guide dogs are the most positive, those who travel unassisted, even though apparently they were helped the most, are the most negative, and cane users fall in between.

11. A number of personality variables were found to be significantly related to evaluation, learning, and performance. With cross-validation data, it should be possible to predict response to the O/D with greater than chance accuracy on the basis of psychometric information. This is a first step toward the establishment of prescription criteria.

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Dear Doctor XXX:

A research project to evaluate a new Obstacle Detector for use by blind individuals is now being carried out by three members of the Department of Psychology (Philip Worchel, Robert K. Young, and myself). This research is sponsored by the Veterans Administration.

Among our subjects is one of your patients. It would be extremely helpful to our project if you could provide the information requested on the enclosed form. A return envelope is provided for your convenience.

Thank you very much for your time and trouble.

Sincerely,

Donn Byrne, Ph. D.
Associate Professor

Your patient's name:

1. What was his visual acuity as of your last examination?

2. What was the widest angle of his visual field as determined in your last examination?

   a. If visual field is of importance in determining visual impairment in his case, please attach a copy of a diagram of his visual field.

3. What was the date of your last examination?

4. According to your records, what was the cause of blindness?

5. Is the cause of his visual impairment a progressive condition?

   a. Would you expect significant changes to have occurred since your last examination?

6. According to your records, at what age did he become totally blind?

_____
(Signature)

Appendix B

Mobility Scale

1. travels in familiar environments with no assistance
   travels in unfamiliar environments with no assistance
2. travels in familiar environments with no assistance
   travels in unfamiliar environments with a cane
3. travels in familiar environments with no assistance
   travels in unfamiliar environments with a guide dog
4. travels in familiar environments with no assistance
   travels in unfamiliar environments with companion
5. travels in familiar environments with a cane
   travels in unfamiliar environments with cane
6. travels in familiar environments with a cane
   travels in unfamiliar environments with a guide dog
7. travels in familiar environments with a cane
   travels in unfamiliar environments with a companion
8. travels in familiar environments with a guide dog
   travels in unfamiliar environments with a guide dog
9. travels in familiar environments with a guide dog
   travels in unfamiliar environments with a companion
10. travels in familiar environments with a companion
    travels in unfamiliar environments with a companion
11. travels in familiar environments with no assistance
    does not travel in unfamiliar environments
12. travels in familiar environments with a cane
    does not travel in unfamiliar environments
13. travels in familiar environments with a guide dog
    does not travel in unfamiliar environments
14. travels in familiar environments with a companion
    does not travel in unfamiliar environments
15. does not travel in familiar environments
    does not travel in unfamiliar environments

Appendix C

Instructions

This device which I have just placed in your hand is called an Obstacle Detector or O/D. When in use it sends out a beam of light from this piece of plastic (E indicates). If the beam of light hits anything within range then the light is reflected back to the O/D. The operator is then given a signal and he knows something is in the way and it should be avoided.

As yet the O/D has not been evaluated systematically, and you have been chosen to serve as a subject so that this device may be evaluated properly. We want to know how easy or difficult it is to learn to use the O/D. We want to know whether it is easy to use or if it is a nuisance. We want to know what is right with the O/D and we want to know what is wrong with the O/D. In order to answer these questions we must train you in the use of the O/D. We will observe how long it takes you to learn to use it, and after you learn how to use it we will compare your feelings about the O/D to your feelings about your usual method of getting around.

Since this device is still in the experimental stages and is in the process of being developed, you should not expect too much of it. For example, you should not expect to use the device in an area which you know nothing about because you can not find holes with it, nor can you find curbs or overhanging objects with it. In short, this device is to be used in a semifamiliar environment such as a bus station or a corridor where you know what to expect in the way of obstacles.

The proper way to hold the O/D is down by your side, like this (E demonstrates) and not in front of you. When you hold the O/D down by your side, you automatically turn it on because the On-Off switch is in the bottom of the handle, and it is pushed in (and on) when you hold the O/D naturally. It will also turn off automatically when you put the O/D down. Hold it down by your side (E demonstrates) and it is automatically turned on. (Different ways of holding are demonstrated here.)

The O/D sends out a beam of light. If the light hits anything within range, it is reflected back and you will get a signal. This signal is given

by this pin located just in front of the On-Off switch. When the light hits something, it is reflected back and the pin vibrates. If the beam of light does not hit anything, the light is not reflected and then the pin does not vibrate.

When the O/D is held at your side with your finger resting lightly on the vibrating pin, the O/D has a range of 10 feet. That is, anything within 10 feet will reflect the beam of light, and the pin will vibrate. As you are given training on the O/D you will learn how to vary the range from 5 feet to 50 feet, but for now we will use only the 10 foot range. However, these initial series of trials will be used to train you on the 10 foot range. (Demonstration of vertical and horizontal sweeping here.)

E gives series 1, 2, and 3

As you may have guessed the vibrating pin is located on the range switch. When the range switch is pushed in like this (E demonstrates) the range is shortened to 5 feet. That is, anything within 5 feet will reflect the light beam while anything over 5 feet will not. Thus, when the range switch is pushed in the O/D will operate just like the 10 foot condition except that the range of the O/D has been reduced to 5 feet. These next series will be used to train you on the use of the distance switches.

Appendix D

Categories of Obstacles:

There are eight categories of obstacles. Below, is a list of the obstacles and their dimensions.

No. 1.	doorway	Two masonite panels (1'3" x 5') set in thin wood frames and standing upright on a wooden base. Wall a. has one white side (painted), one natural side. Wall b. has one black side (black felt) and one natural side. The doorway obstacle is made by placing the panels directly across from each other with $2\frac{1}{2}$' clearance between them. When the doorway obstacle appears in a trial, the two panels are counted as one object and there will be only seven obstacles listed for that trial. When the wall obstacles appear in a trial, the two panels are counted individually and set at varying positions along the course. There will be eight obstacles listed for these trials.
No. 2.	walls	
No. 3.	poles	Two poles (wood) 2" in diameter, 5' high, set in wooden bases 1' diameter and 2" high. The poles are always used together, centered in the course with $2\frac{1}{2}$' clearance between them. Pole a. is painted aluminum. Pole b. is left natural.
No. 4.	wooden box	18" x 18" x 12" constructed of plywood
No. 5.	chair	The chair is an ordinary straight back chair of average size.
No. 6.	garbage can	about 2' in diameter of average height. (a metal can)
No. 7.	person	an assistant who takes a position in each trial.
No. 8.	wire basket	24" high, 1' in diameter

Appendix E

Base Level of Performance

Name _____ Date _____ Mode of travel _____

Time of day _____ Weather Conditions _____

INDOOR TRIALS INDOOR TRIALS

Trial #1

Object	Position	Errors	Time to traverse course
1. Garbage can	R. 20'		
2. White wall	L. 30'		
3. Poles-centered	$2\frac{1}{2}$' apt. 35'		
4. Chair	R. 45'		
5. Person	L. 45'		
6. Wood box	L. 50'		
7. Wire basket	M. 55'		
8. Black wall	L. 75'		

Start at 0'mk. at East end; Finish at 85'mk. at West end.

Trial #2

Object	Position	Errors	Time to traverse course
1. Black wall	L. 10'		
2. Wire basket	M. 30'		
3. Wood box	L. 35'		
4. Person	L. 55'		
5. Chair	R. 55'		
6. Poles-centered	$2\frac{1}{2}$' apt. 65'		
7. White wall	L. 70'		

8. Garbage can	R. 80'	_____	

Start at 0'mk. West end; Finish at 85' East end.

Trial #3

Object	Position	Errors	Time to traverse course
1. Chair	R. 10'	_____	
2. Doorway-centered	$2\frac{1}{2}$' apt. 15'	_____	
3. Wood box	M. 20'	_____	
4. Person	R. 40'	_____	
5. Poles-centered	$2\frac{1}{2}$' apt. 55'	_____	
6. Garbage can	M. 65'	_____	
7. Wire basket	R. 70'	_____	

Start at 0' mk. East end; Finish 85' mk. West end.

Trial #4

Object	Position	Errors	Time to traverse course
1. Wire basket	R. 20'	_____	
2. Garbage can	M. 25'	_____	
3. Poles-centered	$2\frac{1}{2}$' apt. 35'	_____	
4. Person	R. 50'	_____	
5. Wood box	M. 55'	_____	
6. Doorway-centered	$2\frac{1}{2}$' apt. 60'	_____	
7. Chair	R. 65'	_____	

Start at 0' mk. West end; Finish at 85' mk. East end.

Trial #5

Object	Position	Errors	Time to traverse course
1. Black wall	R. 10'	_____	
2. Wire basket	R. 25'	_____	
3. Wood box	L. 25'	_____	
4. Person	M. 30'	_____	
5. White wall	R. 30'	_____	
6. Poles-centered	$2\frac{1}{2}$' apt. 55'	_____	
7. Garbage can	M. 65'	_____	
8. Chair	L. 75'	_____	

Start at 0' mk. East end; Finish at 85' mk. West end.

Appendix F

INTERVIEW I

Name_____ Date_____

Date of Birth_____ Place of birth_____
(city, state)

Present Address_____Phone No._____

O/D INTERVIEW

Were you ever in the Armed Forces?_____

Branch of Service

Army_____ Navy_____ Air Force_____ Marines_____ Coast Guard_____

Other_____

Rank_____(Grade) (VAC#_____)

EDUCATION	B/S	NAME	GRADE COMPLETED	LOCATION
Grammar				
High School				
College				
Technical Training				

Comments:

INTERVIEW I, Continued

TRAVEL TRAINING

Did you ever have any travel training? _____

What types of training did you have? _____

_____

_____

Do you feel that the training has helped you? _____

Comments:

BLINDNESS

a. Age at which totally blind: _____
b. Cause of blindness: _____
c. Sudden: _____ Gradual: _____
d. Treatment: _____
e. Examining Physician: _____ Location: _____

Comments:

Determination of Mobility Competency

A. Determination of Mobility Competency

1. Do you ever go away from the place in which you live? _____
2. If yes, do you ever go alone or do you always go with somebody else? _____
3. When you go alone do you use anything to help you such as a cane, dog, etc. ? _____
4. If (1) is yes, during the last year did you go anywhere that you have never been before? _____
5. If (4) is yes, did you go alone or with somebody else? _____
6. When you went alone, did you use anything to help you such as a cane, dog, etc. ? _____

Name _____ Date _____

O/D Interview II

Now that you have been using the Obstacle Detector for several weeks, we would like to find out what you think of it. The more we can learn about this instrument, the greater chance there is of making it better in the future.

1. First, what is your general evaluation of it? How did you like using it?

Very unfavorable	Unfavorable	Indifferent	Favorable	Very favorable

2. Do you think it would help you in getting around? How useful would it be to you personally?

Not at all useful	Not useful	Of moderate use	Useful	Very Useful

3. Where do you think you would be most likely to use it? In what sort of situations would it be of help to you?

4. Where do you think you would be least likely to use it? In what sort of situations would it be of no help to you?

5. If an Obstacle Detector could be made available to you, do you think you would want to have one?

Not at all	No	Don't care	Yes	Very Much

6. What, in your opinion, are the best features of the Obstacle Detector?

7. What, in your opinion, are the worst features of the Obstacle Detector?

8. Can you think of any changes that might be made in the instrument which would improve it?

9. Do you have any other general comments about the Obstacle Detector?

Appendix G

Nine instruments were received at TRACOR, Inc. in August 1962, and three more instruments were delivered in late February 1963. All instruments were used for a total of approximately 600 hours, for an average use of approximately 50 hours. Since subjects were permitted to choose an instrument they thought best, however, some instruments were used more than others.

Of the twelve instruments, Serial #1-12, number 9 was repaired twice, number 5 once and numbers 1 and 3, three times, the remainder not at all. In every failure but one, the repair was effected by Bionic Instruments, Inc., the manufacturer. The one failure, of number 3, was repaired by TRACOR, Inc. Nine failures in 600 hours of use implies a mean time before failure of about 67 hours.

The repair record follows.

O/D #	Date	Complaint	Diagnosis
1	October 1962	No lamp	4 layer diode failure
5	February 1963	No stimulator	transistor failure
3	March 1963	Range switch stuck "on"	switch touching case
9	March 1963	Intermittant	battery down, possible intermittant in lamp drive circuit
1	April 1963	Near range failure	pin bent--faulty original worksmanship
3	April 1963	No lamp	4 layer diode failure
3	June 1963	Stimulates in absence of target	light leak
1	June 1963	No stimulator	open stimulator coil
9	July 1963	No stimulator	stimulator pin binding socket connections broken

It is to be expected from anything electro-mechanical that there will be failures. The record for these machines is an extremely good one, and should, with continued production of instruments even improve.

Table 1

Background Information on Subjects

ubject	Age	Sex	Years of Education	Age at onset of Blindness	Cause of Blindness	Travel Aid	Mobility Score	Source of Training
A	29	M	12	9	Disease	Cane	2	Lighthouse
B	42	M	14	24	Disease	Cane	2	Self-trained
C	30	M	0	12	Disease	Cane	2	Kerrville L.C**
D	26	M	8	18	Accident	Cane	5	Kerrville L.C.
E	34	M	16	32	Disease	Cane	2	Kerrville L.C.
F	33	M	14	14	Accident	Cane	2	Lighthouse
G	21	M	18	9	Accident	Cane	2	Kerrville L.C.
H	50	M	12	17	Disease	Cane	2	Kerrville L.C.
I	25	M	16	4	Accident	Cane	5	Self-trained
J	58	F	13	43	Disease	Cane	7	Kerrville L.C.
K	27	M	7	Infancy	Congenital	Cane	7	Kerrville L.C.
L	31	F	9	Infancy	Congenital	Cane	5	Kerrville L.C.
M	40	M	6	26	Disease	Cane	7	Kerrville L.C.
N	34	M	18	19	Disease	Dog	3	Seeing Eye***
O	56	M	7	23	Disease	Dog	2	Seeing Eye
P	41	F	14	29	Disease	Dog	9	Seeing Eye
Q	41	M	16	Infancy	Congenital	Dog	3	Seeing Eye
R	22	M	16	9	Disease	None	1	----------
S	18	M	10	4	Disease	None	2	----------
T	14	M	5	10	Disease	None	1	----------
U	22	M	15	3	Accident	None	1	----------
V	19	M	10	14	Disease	None	2	----------
W	43	M	7	18	Disease	None	4	----------
X	18	M	9	13	Disease	None	4	----------
Y	14	M	5	Infancy	Accident	None	1	----------
Z	20	M	12	2	Disease	None*	2	Lighthouse

*Also cane

**Kerrville Lion's Camp(having about half completed the mobility course)

***"Seeing Eye", Morristown

SCORES ON THE PERSONALITY TESTS*

TABLE 2

Subj.	California Psychological Inventory																		WAIS Est.		Emotional Factors Inventory						
	Dominance	Capacity for Status	Sociability	Social Presence	Self Acceptance	Sense of Well Being	Responsibility	Socialization	Self-Control	Tolerance	Good Impression	Communality	Achievement via Conformance	Achievement via Independence	Intellectual Efficiency	Psychological-Mindedness	Flexibility	Femininity	Vocab.	I.Q.	Sensitivity	Somatic Symptoms	Social Competency	Attitudes of Distrust	Feelings of Inadequacy	Depression	Attitudes Regarding Blindness
**B	32	16	22	30	18	42	35	38	41	23	25	27	30	18	37	11	3	20	56	112	3	2	1	0	1	1	0
C	24	12	18	24	14	13	21	30	15	8	13	18	16	4	22	9	1	16	26	92	17	2	15	10	12	12	14
D	27	18	29	28	20	42	32	41	38	25	31	26	32	18	40	13	9	16	30	87	3	2	4	2	1	0	9
E	28	24	28	37	25	40	35	43	34	24	23	27	33	16	42	13	7	18	60	118	0	1	4	3	1	0	1
F	38	22	25	40	21	39	35	33	34	29	16	27	29	23	45	15	16	23	72	135	9	6	7	2	3	0	3
G	38	23	32	46	25	42	35	44	30	30	20	28	34	21	47	13	9	18	76	147	3	2	5	1	1	0	1
H	28	22	29	39	21	40	36	37	41	28	32	28	36	22	43	9	9	18	74	143	0	1	0	3	2	0	1
**J	26	15	22	24	17	38	37	51	40	20	24	28	34	16	40	13	2	20	43	104	2	6	11	3	4	1	4
K	12	5	14	14	12	21	31	32	23	9	7	26	17	9	24	2	3	23	60	117	17	5	19	11	10	9	8
L	31	17	22	28	21	21	25	28	21	14	18	25	23	15	27	10	4	23	65	123	13	8	3	11	8	6	5
M	24	10	22	21	17	9	18	24	10	4	11	18	14	4	16	5	1	19	15	70	--	--	--	--	--	--	--
N	35	22	28	36	24	37	35	29	35	23	22	28	27	17	40	13	8	25	70	129	2	1	4	4	2	0	3
O	20	10	18	24	16	18	21	25	13	4	10	19	15	2	19	5	1	15	26	92	17	2	15	13	12	12	14
P	39	25	31	44	21	43	39	38	35	26	19	28	35	18	42	15	9	22	63	123	2	3	5	2	2	1	2
Q	29	18	27	34	23	36	34	38	19	19	13	28	27	13	41	7	6	12	---	---	--	--	--	--	--	--	--
R	21	15	25	35	23	38	28	31	33	17	26	25	23	19	34	11	7	21	70	130	4	5	2	6	5	3	0
S	25	21	26	39	20	35	33	41	26	26	10	28	22	23	38	12	12	16	55	114	10	4	7	2	2	0	5
T	24	8	18	25	16	22	19	27	19	7	11	26	15	12	21	7	6	17	42	88	18	7	13	17	15	11	15
U	21	24	22	43	24	26	27	28	15	16	8	26	21	17	39	14	17	17	74	142	13	7	11	8	10	2	6
V	18	8	20	33	15	23	14	18	15	8	4	22	11	9	24	9	6	10	30	91	12	6	7	4	5	3	6
W	28	12	25	31	18	39	30	42	34	17	27	26	30	13	34	8	3	16	25	82	--	---	--	--	--	--	-
X	15	15	13	31	17	30	17	26	20	15	13	24	18	11	20	13	11	16	25	85	14	15	11	8	8	8	10
Y	22	14	21	27	17	26	23	34	24	11	20	21	21	14	30	10	11	18	---	---	7	6	8	11	7	4	11
Z	21	11	22	20	15	35	28	42	36	16	22	28	20	14	34	9	4	22	35	94	--	--	--	--	--	--	--
Means	26	16	23	31	19	31	29	34	27	18	18	25	25	15	33	10	7	18	49	109	8	5	7	6	5	3	6

*Entries are raw scores. These scores may be converted to standard scores through use of the copyrighted Profile Sheet published by Consulting Psychologists Press, Inc., Palo Alto, California.

**Subjects A and I failed to complete the tests.

Detector (Post-Learning)

Table 3

Subj.	Travel Aid	Pre-Learning Outdoor (85') Errors	Pre-Learning Outdoor (85') Time	Pre-Learning Indoor (95') Errors	Pre-Learning Indoor (95') Time	First Post-Learning Outdoor (85') Errors	First Post-Learning Outdoor (85') Time	First Post-Learning Indoor (95') Errors	First Post-Learning Indoor (95') Time	Second Post-Learning Outdoor (85') Errors	Second Post-Learning Outdoor (85') Time	Second Post-Learning Indoor (95') Errors	Second Post-Learning Indoor (95') Time
A	cane	0.8	43	0.8	55	2.2	99	2.0	119	1.8	66	2.6	106
B	cane	1.2	75	1.2	69	1.6	103	1.0	117	2.2	106	1.8	147
C	cane	2.0	44	2.2	44	2.0	89	1.2	63	1.2	59	1.4	59
D	cane	1.4	50	1.6	68	1.4	62	1.8	50	1.4	58	1.6	70
E	cane	1.4	58	2.2	73	1.4	217	1.6	223	1.6	137	1.2	123
F	cane	2.2	99	2.6	98	1.6	162	1.0	203	1.8	116	1.2	126
G	cane	0.6	52	0.4	56	1.0	184	1.6	255	1.8	132	1.8	223
H	cane	2.2	50	1.6	57	2.0	137	3.0	136	2.0	207	2.6	192
I	cane	1.6	39	2.2	36								
J	cane	0.2	47	0.6	75	1.0	147	1.0	192				
K	cane	1.0	39	0.6	36	3.2	137	1.4	173				
L	cane	0.2	51	1.2	60	2.4	138	2.4	135				
M	cane	(See page 22)											
N	dog	1.4	21	1.1	24	2.2	87	2.2	120	2.0	159	0.8	132
O	dog	1.4	31	1.4	34	1.8	114	1.6	141	2.2	160	1.2	132
P	dog	0.4	33	0.6	31	1.2	161	2.0	165				
Q	dog	0.2	29	0.6	27								
R	none	2.4	71	2.0	122	1.2	145	1.6	133	1.4	148	0.6	100
S	none	5.4	40	5.6	51	2.2	230	2.2	162	2.4	263	3.0	162
T	none	3.4	63	2.4	116								
U	none	2.8	67	3.2	135								
V	none	5.2	57	4.8	53	2.0	227	1.8	159	2.0	237	2.0	194
W	none	4.8	54	4.3	62								
X	none	4.8	52	3.4	54	2.6	144	2.8	99	2.4	82	2.0	83
Y	none	0.4	78	0.2	61								
Z	none	4.0	81	3.6	77	3.0	122	2.4	151				

Table 4

Mean Errors and Time (Sec.) on the Obstacle Course Without (Pre-Learning) and With the Obstacle Detector (Post-Learning) According to Travel Aid*

		Pre-Learning				First Post-Learning			
		Outdoors		Indoors		Outdoors		Indoors	
Travel Aid	N	Errors	Time	Errors	Time	Errors	Time	Errors	Time
Cane	11	1.20	55.3	1.36	62.8	1.80	134.1	1.64	151.5
Dog	3	1.07	28.3	1.03	29.7	1.73	120.7	1.93	142.0
None	5	4.36	60.2	3.88	71.4	2.20	173.6	2.16	140.8
All Ss	19	2.01	50.8	1.97	59.8	1.89	142.4	1.82	147.2

* The seven subjects who had not taken the post-learning tests are not included in this comparison.

Table 5

Mean Errors and Time (Sec.) on the Standard Obstacle Course Under "Speed" Instructions (With O/D)

	Outdoors (85')		Indoors (95')	
Subject	Errors	Time	Errors	Time
A	0.4	64	1.4	95
B	1.1	64	1.4	99
C	2.0	57	1.8	88
D	2.2	77	2.4	71
E	0.4	52	1.2	54
F	3.8	47	2.8	54
G	2.4	64	2.2	54
H	2.5	65	2.0	70
N	1.8	62	1.6	60
O	2.6	136	1.8	124
R	1.8	61	1.6	60

Table 6

Mean Errors and Time (Sec.) on the Obstacle Course Under Normal (Pre-Learning and First Post-Learning) and Speed Trials (N=11)

	Pre-Learning				First Post-Learning				Speed Trials			
	Outdoor		Indoor		Outdoor		Indoor		Outdoor		Indoor	
	Errors	Time	Errors	Time	Errors	Time	Errors	Time	Errors	Time	Errors	Time
Mean	1.54	54.0	1.55	63.6	1.67	127.2	1.69	141.8	1.95	68.1	1.84	75.4
SD	.57	20.6	.64	26.6	.39	44.5	.61	60.0	.97	22.6	.33	22.0

Table 7

Total Errors and Time (Sec.) on the Field Course
With Customary Travel Aid (Without O/D) and with the Obstacle Detector

Subject	Travel Aid	Without O/D		With O/D	
		Errors	Time	Errors	Time
A	cane	1	180	4	205
B	cane	2	436	3	488
C	cane	1	490	4	510
D	cane	2	421	3	433
E	cane	1	165	0	175
F	cane	2	195	6	285
G	cane	3	319	3	353
H	cane	2	359	1	449
N	dog	1	298	3	460
O	dog	1	450	4	511
R	none	1	420	5	423
S	none	7	1215	4	420
V	none	5	1050	3	420
X	none	7	838	5	465
Mean		2.6	488	3.4	399.8

Table 8

TOTAL ERRORS ON EACH OBSTACLE FOR ALL AVAILABLE SUBJECTS IN THE PRE-LEARNING, THE TWO COMBINED POST-LEARNING, AND SPEED TRIALS

Obstacle	Pre-Learning: Cane Errors	Cane Per Cent	Dog Errors	Dog Per Cent	None Errors	None Per Cent	Post-Learning Errors	Post-Learning Per Cent	Speed Errors	Speed Per Cent
Garbage Can	22	24	6	20	54	54	136	49	53	48
White Wall	8	13	2	11	17	28	18	11	6	9
Black Wall	14	23	3	17	12	20	21	13	7	11
Doorway	19	48	4	33	23	58	54	48	20	45
Poles	37	41	5	17	41	41	84	30	26	24
Chair	16	18	1	33	32	32	89	30	24	22
Person	46	51	13	43	34	34	52	19	10	9
Wood Box	16	18	1	33	44	44	94	34	26	24
Wire Basket	18	20	1	33	38	38	118	42	30	27

Table 9

SUBJECT'S EVALUATIONS OF THE O/D

	Interview I			Interview II		
	General Evaluation	Usefulness	Would you Want one?	General Evaluation	Usefulness	Would you Want one?
A	indifferent	not useful	yes	unfavorable	not useful	yes
B	favorable	of moderate use	yes	very fav.	very useful	very much
C.	favorable	useful	yes	indifferent	of moderate use	don't care
D	favorable	of moderate use	yes	favorable	of moderate use	don't care
E	favorable	of moderate use	yes	favorable	of moderate use	yes
F	indifferent	of moderate use	yes	indifferent	of moderate use	yes
G	favorable	not at all useful	no	favorable	not at all useful	no
H	favorable	not at all useful	not at all	unfavorable	not useful	no
J	favorable	very useful	yes			
K	favorable	not at all useful	no			
L	favorable	of moderate use	yes			
N	unfavorable	of moderate use	no	favorable	useful	yes
O	favorable	of moderate use	don't care	indifferent	of moderate use	don't care
P	very fav.	useful	yes			
R	unfavorable	not at all useful	no	unfavorable	not at all useful	no
S	favorable	useful	yes	indifferent	of moderate use	no
T	favorable	useful	yes			
U	favorable	not useful	don't care	indifferent	not useful	don't care
V	favorable	of moderate use	yes	favorable	of moderate use	no
X	unfavorable	not useful	yes	favorable	of moderate use	yes
Y	very fav.	useful	yes			
Z	very fav.	of moderate use	yes			

Table 10

Correlations between Personality Variables and Subjective Evaluations of the O/D

	First Interview		
	General Evaluation	Usefulness	Desire to Own O/D
Age	x	.44*	x
Education	x	x	-.39*
Mobility Score	.44*	.57**	x
Self-acceptance	x	x	-.41*
Femininity	x	x	-.38*
Verbal I.Q.	x	x	-.56*
Post-learning			
outdoor errors	-.54**	-.41*	x
indoor errors	-.51**	-.50**	x

	Second Interview		
	General Evaluation	Usefulness	Desire to Own O/D
Mobility Score	.43*	x	x
Social Presence	x	-.48*	x
Pre-learning			
Indoor Time	x	-.44*	x
Post-learning			
Outdoor Errors	x	.47*	x
Learning			
(first stage)			
time to criterion	x	.43*	x

* = $p < .10$ ** = $p < .05$ x = Correlation not Statistically Significant

Table 11

Correlations Between Personality and Learning Variables

	First Stage			Second Stage			Third Stage		
	Errors	Time	Trials	Errors	Time	Trials	Errors	Time	Trials
Dominance	x	x	.44*	x	x	x	.45*	.43*	.43*
Psychological - Mindedness	x	x	x	x	.45*	x	x	x	x
Flexibility	x	x	x	x	.62*	x	.45*	.45*	.46*
Somatic-Symptoms	x	x	x	x	.60*	x	x	x	x

* = $\underline{p} < .10$ ** = $\underline{p} < .05$ x = Correlation not statistically significant

Table 12

Correlations between Personality Variables and Obstacle Course Performance

	Pre-learning				Post-learning			
	Outdoor		Indoor		Outdoor		Indoor	
	Errors	Time	Errors	Time	Errors	Time	Errors	Time
Age	-.60** *	x	-.59** *	x	x	x	x	x
Education	x	x	x	x	x	x	x	.59** *
Mobility Score	-.44*	-.45*	-.43*	-.43*	-.66** *		-.56**	--
Responsibility	-.49**	x	-.39*	x	-.41*	x	x	-.41*
Socialization	-.40*	x	x	x	x	x	x	x
Good Impression	-.39*	x	-.45*	x	x	x	x	x
Achievement via Conformance	-.47**	x	-.44*	x	x	x	x	x
Flexibility	.40*	x	.42*	.41*	x	x	x	x
Femininity	-.49**	x	-.47**	x	-.53**	x	-.47**	x
Social Presence	x	x	x	x	x	.42*	x	.43*
Self-Acceptance	x	x	x	x	x	x	x	.42*
Communality	x	x	x	x	x	x	x	.49**
Intellectual Efficiency	x	x	x	x	x	x	x	.46**
Somatic Symptoms	x	x	x	.44*	-.44*	x	-.50*	x
Att. vs. Blindness	x	x	x	x	x	x	x	-.54**
I.Q.	x	x	x	x	x	x	x	.59** *

* = $\underline{p} < .10$ ** = $\underline{p} < .05$ ** * = $\underline{p} < .001$ x = Correlation not Statistically Significant

Table 13

Correlations between Personality Variables and Performance on the Field Course

	With O/D		Without O/D	
	Errors	Time	Error	Time
Dominance	x	x	.67**	x
Capacity for Status	-.48*	x	x	x
Sociability	-.57**	x	.59*	x
Social Presence	x	x	.53*	x
Self Acceptance	-.49*	x	x	x
Responsibility	-.45*	x	.55*	x
Socialization	x	x	.55*	x
Tolerance	x	x	.67**	x
Achievement Via Conformance	-.51*	x	.61**	x
Achievement Via Independence	x	x	.52*	x
Intellectual Efficiency	x	x	.58*	x
Sensitivity	.56**	x	x	x
Somatic Symptoms	.46*	x	x	x
Social Competency	.52*	x	x	x
Attitudes of Distrust	x	x	.67**	x
Feelings of Inadequacy	.51*	x	-.52*	x

* = $p < .10$ ** = $p < .05$ x = Correlation not Statistically Significant

March 12, 1964

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